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Response of Gambel Oak to Tebuthiuron in Central Utah

**Warren P. Clary
Sherel Goodrich
Benton M. Smith[1]**

ABSTRACT

Tebuthiuron was aerially applied on a Gambel oak stand at rates of 1.1, 2.1, and 3.2 lb/acre (1.2, 2.4, and 3.6 kg/ha) active ingredient. Control of Gambel oak exceeded 98 percent for all treatments the third growing season after application. Total understory production was reduced by the 2.1 and 3.2 lb/acre rates, while cheatgrass brome greatly increased under the 1.2 lb/acre rate.

KEYWORDS: tebuthiuron, herbicide, Gambel oak, *Quercus gambelii*

Gambel oak (*Quercus gambelii* Nutt.) occurs almost entirely within Arizona, Colorado, New Mexico, and Utah (Little 1971). It is a rhizomatous species that typically is found in dense, clonal, shrublike clumps in the northern and middle portions of its range, and often with treelike stature in more open stands in the southern portion of its range.

When clonal groups are contiguous or nearly so, large areas may be almost impenetrable. Thus, objectives of land managers may include reductions in Gambel oak density or continuity in order to increase livestock forage (Marquiss 1969), to improve habitat diversity for wildlife (Steinhoff 1978), or perhaps to increase water yield (Grover and others 1970). Although burning, mechanical, and chemical techniques have been used to remove Gambel oak stems, it is a very persistent species that sprouts readily from an extensive underground structure (Engle and others 1983).

Tebuthiuron (N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N′-dimethylurea) has effectively controlled many other oak species. Application rates of 2.0 lb/acre (2.2 kg/ha) active ingredient (a.i.) controlled 100 percent of the blackjack oak (*Q. marilandica* Muenchh.) on a fine sandy loam site in Oklahoma (Shroyer and others 1979). In Texas, 0.8 lb/acre (1 kg/ha) of tebuthiuron provided effective control of sand shinnery oak (*Q. havardii* Rydb.) on fine sand sites (Pettit 1979; Jacoby and others 1983). Post oak (*Q. stellata* Wangenh.), blackjack oak, and water oak (*Q. nigra* L.) canopies were reduced 98 to 100 percent in most situations by 2.0 lb/acre (2.2 kg/ha) in the post oak savannah of Texas (Scifres and others 1981a). Tebuthiuron was effective in controlling shrub live oak (turbinella oak, *Q. turbinella* Greene) on clayey soils in Arizona (Davis and others 1980). Control of woody overstory species has often resulted in a several-fold increase in forage, particularly if tebuthiuron was applied at 2.0 lb/acre (2.2 kg/ha) or less (Pettit 1979; Scifres and Mutz 1978; Scifres and others 1981b).

Tebuthiuron did not control Gambel oak at rates of 0.7 to 2.2 lb/acre (0.8 to 2.5 kg/ha) on heavy-textured shale-derived soils in southwestern Colorado, and understory herbage production was depressed (Bartel and Rittenhouse 1982). Britton and Sneva (1981) also reported sensitivity of cool-season herbaceous plants to tebuthiuron in the Intermountain region.

The objectives of this investigation were to evaluate tebuthiuron for control of Gambel oak on a central Utah site and to evaluate the response of herbaceous and shrubby understory species.

METHODS

The test site was in Millard County, Utah, about 6 mi (10 km) south of Scipio. Average annual precipitation is 15 inches (38 cm), the major portion falling October to May. In the 3 years following herbicide application, precipitation averaged 54, 1, and 62 percent above the long-term mean, based on records from nearby communities. The test site was on a uniform alluvial-colluvial fan at the base of the Pavant Mountains at 5,800 ft (1 770 m) elevation. The surface soils were sandy loams to gravelly sandy loams developed from quartzite parent rocks. Soil texture ratios of sand:silt:clay varied from 62:28:10 with 8 percent gravel under Gambel oak clumps to 77:15:8 with 20 percent gravel in the interclump areas. Organic matter in the surface soil was about 9 percent under the oak and about 5 percent between oak clumps.

[1]Authors are supervisory range scientist, Forestry Sciences Laboratory, USDA Forest Service, Boise, ID; range conservationist, Vernal Ranger District, Ashley National Forest, USDA Forest Service, Vernal, UT; and range conservationist, Fillmore Ranger District, Fishlake National Forest, USDA Forest Service, Fillmore, UT.

In October 1979, pellets containing 40 percent a.i. tebuthiuron were aerially applied to parallel strips 168 ft (51 m) wide and 0.25 mi (0.4 km) long at rates of 1.1, 2.1, and 3.2 lb/acre (1.2, 2.4, and 3.6 kg/ha). Each rate was applied to a single strip oriented on the contour. Buffer zones 100 ft (30 m) wide were located between test strips. The sequence of strips, including a control strip, was randomized. The 0.25-mi (0.4-km) strips were assumed to adequately represent the plant community's response to each tebuthiuron rate; however, because the strips were not replicated no statistical inferences are presented.

Vegetation response was sampled during late July in 1980, 1981, and 1982. Each strip was systematically sampled by 30 sets of nested temporary plots. A set consisted of two concentric circular plots—a 1,075.8-ft^2 (100-m^2) plot for sampling damage to Gambel oak (percent dead crown), and a 9.6-ft^2 (0.9-m^2) plot for sampling herbaceous vegetation and shrub leaf and twig production. Individual oak stems over 5 ft (1.5 m) tall were categorized into 5-ft (1.5-m) height classes. Oak stems less than 5 ft (1.5 m) tall were classified collectively as "sprouts" and given one damage rating for the plot.

Herbage production was determined by weight estimate. Every fifth plot was clipped, ovendried, and weighed as a basis for correction of estimated wet weight to a dry weight basis.

RESULTS AND DISCUSSION

Because of the poor response reported by Bartel and Rittenhouse (1982), we did not expect Gambel oak to respond quickly to tebuthiuron application. However, phytotoxicity symptoms appeared the first growing season. Defoliation exceeded 40 percent for all application rates by midseason (table 1). The Gambel oak experienced several defoliation-refoliation cycles the first growing season as described by Scifres and others (1981a). The greater the herbicide rate, the more rapidly the cycle occurred.

Treatments were first evaluated the third week in July 1980. At that time the oak subjected to the heaviest rate of tebuthiuron had already defoliated and had regrown some leaves. This resulted in a lower crown damage or defoliation rating than for plants subjected to lower herbicide rates (table 1). Crown kill and apparent plant kill ranged from 74 to 98 percent the second growing season. In the third growing season, plant kill was 98 to 99 percent for all application rates. No data were collected the fourth growing season, but observations in June 1983 indicated 100 percent Gambel oak plant kill under the 2.1 and 3.2 lb/acre (2.4 and 3.6 kg/ha) rates and near 100 percent kill under the 1.1 lb/acre (1.2 kg/ha) rate with only an occasional live stem present.

There was no evidence of variation in susceptibility to tebuthiuron among height classes of oak stems. This is not surprising considering the underground structure of Gambel oak. Unpublished data show a greater biomass below ground than above ground, and that all stems in a clonal group (clump) are tied together by an intensive interconnected network of lignotubers, rhizomes, and roots. These structures appear to graft readily, facilitating the transfer of herbicide throughout the clonal system. Thus, all stems may be potentially affected to a similar degree particularly if death occurs to all or nearly all of the underground system.

The understory in the test area was depauperate, with few species and little production. This understory plant community was strongly affected by the herbicide in each of the three posttreatment years (table 2). In 1982, the third year after application, the two highest application rates still depressed production of the forb and shrub groups and total understory production. Mountain big sagebrush (*Artemisia tridentata vaseyana* [Rydb.] Beetle), which was severely reduced by all application rates, was the understory plant most sensitive to the herbicide. Broom snakeweed (*Xanthocephalum sarothrae* [Pursh] Shinners), which had its highest production in the light treatment strip, was perhaps the plant least affected by the herbicide. This may be in part because broom snakeweed, with its less extensive root system, was not as susceptible as large shrubs to the distribution pattern of 40 percent a.i. pellets; therefore, many old and new snakeweed plants could respond to release from oak overstory dominance.

Annual grasses, principally cheatgrass brome (*Bromus tectorum* L.), increased in the light treatment strip (1.1 lb/acre or 1.2 kg/ha) in 1982 after death of the Gambel oak overstory, but decreased on the area treated at the 3.2 lb/acre (3.6 kg/ha) rate (table 2). The highest application rate with its correspondingly higher pellet density on the soil surface would directly affect more of the cheatgrass plants—approximately one pellet vs. three pellets per 2 ft^2 (0.2 m^2) (Elanco Products Company 1983).

This study area, with its coarse-textured soils, was one on which tebuthiuron was exceptionally effective against Gambel oak. Many sites, perhaps most sites, would likely not experience such a high rate of oak control at the same application rates. Observation suggests that most Gambel oak sites would have finer textured soils and, most likely, higher amounts of soil organic matter, both of which reduce effectiveness of tebuthiuron (Chang and Stritzke 1977; Duncan and Scifres 1983).

The few understory perennial plants originally under the oak stand were also severely affected by the herbicide. These and similar results on a nearby pinyon-juniper (*Pinus-Juniperus*) tebuthiuron test area (Clary and others 1985) and results from related areas (Bartel and Rittenhouse 1982; Britton and Sneva 1981) suggest that application rates sufficiently high to remove tree-size woody overstories will be very damaging to native perennial forage plants in the Intermountain region. This

Table 1.—Percentage Gambel oak defoliation (1980, 1981) and plant kill (1982) by tebuthiuron in central Utah

	Tebuthiuron, lb/acre (kg/ha)			
Year	Control	1.1(1.2)	2.1(2.4)	3.2(3.6)
1980	0	58.6	70.8	49.8
1981	0	74.3	93.7	98.2
1982	0	99.3	99.6	98.6

Table 2.—Understory species production after application of 40 percent of active ingredient tebuthiuron pellets to a Gambel oak community

	Active ingredient, lb/acre (kg/ha)											
	1980				1981				1982			
Species	Control	1.1(1.2)	2.1(2.4)	3.2(3.6)	Control	1.1(1.2)	2.1(2.4)	3.2(3.6)	Control	1.1(1.2)	2.1(2.4)	3.2(3.6)
	Lb/acre											
ANNUAL GRASSES												
Cheatgrass brome *(Bromus tectorum L.)*	36	13	6	4	3	11	5	0	214	548	214	95
Others	0	0	0	0	0	0	0	0	1	1	0	1
Total	36	13	6	4	3	11	5	0	215	549	214	96
PERENNIAL GRASSES												
Bluebunch wheatgrass *(Agropyron spicatum* [Pursh] Scribn. and Sm.)	2	2	2	0	0	7	0	0	1	5	0	0
Sandberg bluegrass *(Poa secunda* Presl.)	5	9	9	8	0	0	0	0	5	6	2	0
Bottlebrush squirreltail *(Sitanion hystrix* [Nutt.] J. G. Sm.)	T	1	0	0	0	0	0	0	3	2	1	1
Others	2	0	T	0	0	0	0	0	2	3	0	1
Total	9	12	11	8	0	7	0	0	11	16	3	2
FORBS												
Peavine *(Lathyrus brachycalyx* Rydb.)	0	0	0	0	0	0	0	0	29	7	0	0
Others	7	2	1	2	0	0	0	0	1	19	1	1
Total	7	2	1	2	0	0	0	0	30	26	1	1
SHRUBS												
Mountain big sagebrush *(Artemisia tridentata vaseyana* [Rydb.] Beetle)	46	1	2	0	25	0	0	0	113	1	0	0
Broom snakeweed *(Xanthocephalum sarothrae* [Pursh] Shinners)	3	1	1	0	2	9	8	3	7	69	11	7
Others	0	2	0	0	0	0	0	0	0	0	0	T
Total	49	4	3	0	27	9	8	3	120	70	11	7
GRAND TOTAL	101 (113 kg/ha)	31 (35 kg/ha)	21 (24 kg/ha)	14 (16 kg/ha)	30 (34 kg/ha)	27 (30 kg/ha)	13 (15 kg/ha)	3 (3 kg/ha)	376 (421 kg/ha)	661 (741 kg/ha)	229 (257 kg/ha)	106 (119 kg/ha)

result is different from that experienced in Texas where perennial forages regularly increase severalfold following tebuthiuron application to oak stands.

In the central Intermountain area reseeding would need to follow most tebuthiuron broadcast Gambel oak treatments to attain a productive forage stand. The combined expense of the herbicide treatment and reseeding may eliminate the use of tebuthiuron on a broad scale. A more likely use of tebuthiuron may be for localized control of Gambel oak to establish travel corridors through dense stands and to develop openings for various uses.

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